

Earth Rotation and Global Change

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Global climate change, whether from natural or man-made causes, can be expected to lead to changes in the Earth's rotation. General Circulation Models (GCMs) of the atmosphere that have been used to study the effects of changes in the amount of atmospheric greenhouse gasses generally predict the globally averaged temperature to increase by 1°-4°C during the next century. This temperature increase is not expected to occur uniformly over the globe, but should exhibit regional variations. This changing atmospheric temperature field will cause changes in the atmospheric wind field and hence, in the atmospheric angular momentum (AAM). Since the angular momentum of the atmosphere-solid Earth system is conserved, a thermally-induced change in the AAM will cause consequent changes in the rotation of the solid Earth.

As the temperature increases, the sea level should rise due to a combination of thermal expansion of the existing water in the seas, and to an increase in the mass of the water in the seas due to the melting of glaciers and ice sheets. Recent analyses of tide gauge data indicate that the sea level has increased by about 1-2 mm/yr for the past 80 years or so. Roughly half this increase, is thought to be due to thermal expansion, with the remainder due to increasing water mass. As the glaciers and ice sheets melt, the load on the Earth's crust and mantle decreases with a consequent rebound of the crust and mantle beneath the glaciers and ice sheets. Similarly, as additional mass is added to the seas, the load on the crust and mantle beneath the seas increases with a consequent depression of the oceanic crust and mantle. This change in the shape of the Earth's crust and mantle, along with the redistribution of the water mass from the glaciers and ice sheets into the ocean basins, causes the Earth's mass distribution to change, which, by definition, causes the Earth's inertia tensor to change, and hence, by conservation of angular momentum, causes the Earth's rotation to change.

These expected effects of global climate change and their influence on the Earth's rotation will be reviewed with particular emphasis on whether or not they can be detected in the observations of the rotation of the solid Earth.

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